Interface for the Documentation and Compilation of a Library of Computer Models in Physiology

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ABSTRACT

A software interface for the documentation and compilation of a library of computer models in physiology was developed. The interface is an interactive program built within a word processing template in order to provide ease and flexibility of documentation. A model editor within the interface directs the model builder as to standardized requirements for incorporating models into the library and provides the user with an index to the levels of documentation. The interface and accompanying library are intended to facilitate model development, preservation and distribution and will be available for public use.

INTRODUCTION

Computer models are used by both the research scientist and the educator for the study of physiological systems. Hence, there are a large number of models currently being developed in many academic institutions. These models represent the distillation of our knowledge of the dynamic functioning of biological systems and serve as a statement of hypothesis or theory [1,2]. Because of this increasing important role for computer models in the biological sciences their development and preservation now deserve special consideration. Some of these models make their way into the formal literature but many are kept within the creating institute for local use. We have found within our department an increasing need to better document and preserve the models we create in order to provide consistency to the knowledge base concerning the theoretical mechanisms of functioning of these systems. Better documentation delineates the assumptions and methods used in the development of the model or theory, whereas a systematic method of compiling these models into an organized library system allows for better distribution of available models. Since models are often built upon a common database of existing experimental evidence from the literature, this approach will hopefully prevent the continual "reinvention of the wheel" by the modeler and provide a starting point for the theorist. While a single model may look at one particular system or organ, a modeling library has the potential to allow us to compare and combine models and systems and take a more integrated view of the structure and workings of the overall organism. A similar approach has been used for the library database of the human gene map [3].

THE COMPUTER MODEL LIBRARY

The idea for a computer model library came from the necessity to better organize and document the modeling efforts within our own department. Computer modeling has been an integral part of our department beginning in the late 1950's and has been used in collaboration with experimental studies to develop hypotheses concerning the mechanisms of physiological systems [4]. Some of these models include the well known Guyton cardiovascular model [5] and HUMAN developed by Coleman [6]. Since those early beginnings, our department has developed hundreds of models of a variety of types. While some of these models are quite large, consisting of several hundred equations, many of these models are small models designed to facilitate a particular research project or to assist a student in learning. Many of these models are often lost over the years or are too poorly documented for others to

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use. The purpose of the computer model library is to provide a mechanism for preserving these models and to standardize a methodology for their documentation. This is in the hope that we might better collaborate our theoretical efforts and build upon existing ideas by using these models in computer simulation studies. This goal is in part the mission of Project 1 of our departmental Program Project Grant HL-11678 from NIH.

Standardization

In determining the best methods for standardizing documentation within the library, we considered three classes of library users. The library will first be used by established modelers as a reference point for developing more models. As noted before, models are a statement of hypothesis. Any such statement should have listed the basic assumptions used in the development of the hypothesis. Hence, the library should include a mechanism for detailing the intricate structure of the model through equations and block diagrams along with annotation as to the assumptions by which these relations were derived.

The second class of library user will include the student or novice modeler who might want to dissect and study the model and incorporate parts into new models. Therefore, it was felt that the contents of the library should be very portable and easily manipulated within the environment of today's mainstream software and word processors.

Finally, there are some users with no modeling experience who are only interested in the results of the models and their theoretical implications. The library then will be required to be dynamic and capable of easily using the models in computer simulation studies to test new ideas. We have utilized VisSIM, a commercially available simulation package and MODSIM, a simulation support software developed in our department [7,8]. However, a library by tradition has all types of books. Likewise, a computer model library should be flexible enough to hold all types of models and methods of simulation. This will help assure the greatest usefulness and prevent the alienation of a group of modelers and limit the scope of the library. These were the considerations used in the development of the software interface and led to the development of a standard set of rules for inclusion into the library.

Library rules

A set of rules for standardization were drafted and are presented in outline form.

1. Required Basic Ingredients for any accepted model.
   - a. Title Page
     1. Title
     2. Author
     3. Affiliation
   - b. Keywords
   - c. Abstract
   - d. Schematic of model system.
     VisSIM diagram or standard electrical engineering format.
   - e. Equations
     1. FORTRAN
     2. C language
     3. Alphanumeric
   - f. Parameter set - baseline values with units specified
   - g. References - AJP format
   - h. Compiled executable form
   - i. Optional - desired features
     1. References for individual equations.
     2. Graphical representations of model parts
     3. Annotation on model derivation

2. Other Library Components - accepted additions to the library

   a. Executable forms of models where the author does not want to reveal the equations.

   Minimum requirements

   a. Title page
   b. Keywords
   c. Abstract
   d. References

   b. Function curves of organ systems
   a. Title page
   b. Equation
   c. Parameter set
   d. References
   e. Optional -Schematic/graphic

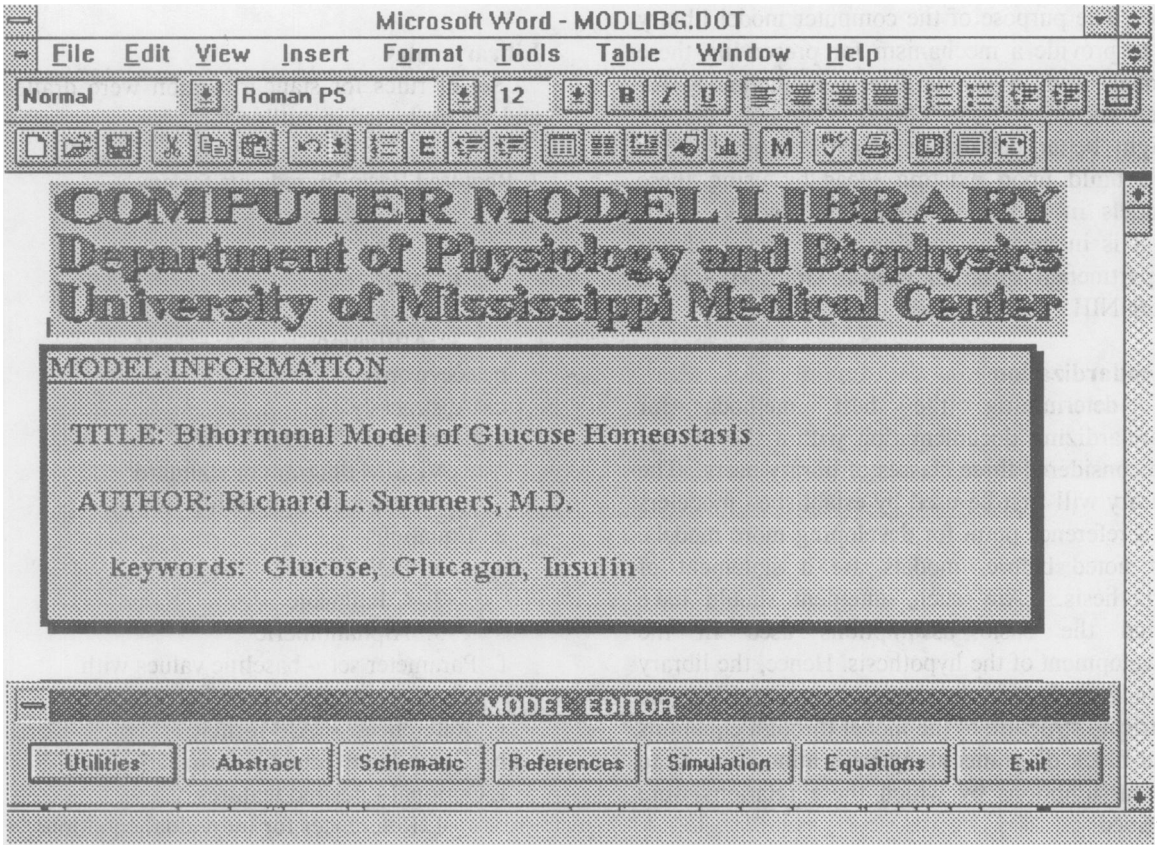

Figure 1. Model Library interface title page with Model Editor

LIBRARY INTERFACE

The software interface for the library was developed as an interactive template for Microsoft's Word for Windows. This flexible word processor allows the user to program macros within a template document using a language called WordBasic which is similar to the Visual Basic used by windows programmers [9]. The macros within the template enable the Word document to act as an interactive program with popup menus, buttons and bookmarks. These functions can be used to direct operations in the word-processing environment. Subroutines within the macros also allow the user to run Windows applications from within the document. Using these utilities, a full featured Model Editor was developed that has the flexibility of a word processor with the power of the Windows application functions. Upon execution of the Model Library icon, the interface template and model editor are installed in a window and are ready for use in model documentation (see Figure 1).

Model Editor

The functions of the Model Editor reflect the requirements stated in the library rules. Selecting a function key brings the user to the appropriate subsection of the model document and calls forth a nested set of additional function keys. Within the abstract section the user is directed to input a title, author and keywords for the model. These inputs are saved and installed in the global context of the word processor and serve as the database for indexing in our library. The equation, schematic and references subsections provide frameworks for documenting these model features with annotation windows for detailed clarification if needed. The word processing environment allows for full feature editing including transfers to and from the clipboard and importation of equations into simulation support software packages. The utilities and equation sections also provide access

to graphics and calculator accessories available within Microsoft Word. Since an executable form of the model is the ultimate goal of the library, a simulation subsection is necessary. In our department the Model Editor has been programmed to shell out to either VisSim or MODSIM for simulation purposes. This feature can readily be adapted to accommodate almost any simulation support software that the user desires. It is our wish that the library be open to any type of modeling or simulation as long as the basic requirements for documentation are met.

Once the fully documented new model is saved it can exist alone as a separate template to be used at a later date.

FUTURE GOALS

At present a variety of previously developed models are being incorporated into the model library using VisSim and the present library interface. New models within the department are also being developed using the model format as outlined by the model editor. As the library expands it is our plan to develop a catalog system that uses the global variables of the keywords along with author and title information to index the library and make it more user friendly. The model library will be placed in our departmental and university network system and hopefully will be available on the Internet in the future.

CONCLUSION

As biomedical scientists increasingly use models to describe and communicate their ideas, the development of a library that can document and preserve these models will be very important. Since modeling and systems analysis in general is an integrative task, a standardized method for communicating these models is needed. This paper describes a dynamic software interface developed for a computer model library based upon a standard set of library rules. The interface is felt to be flexible and can accommodate many kinds of models. As the library is further developed it is the desire of the authors that the interface will serve as a medium for the dissemination and reception of a variety of models from within the scientific community at large. (Microsoft and VisSim are licensed trademarks) (Supported by HL-51971)

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